Aug. 1, 1961 E. L. BREVIK 2,994,165

EQUIPMENT AND PROCESS FOR DEBURRING AND BURNISHING METAL PARTS

Filed Feb. 6, 1959 2 Sheets-Sheet 1

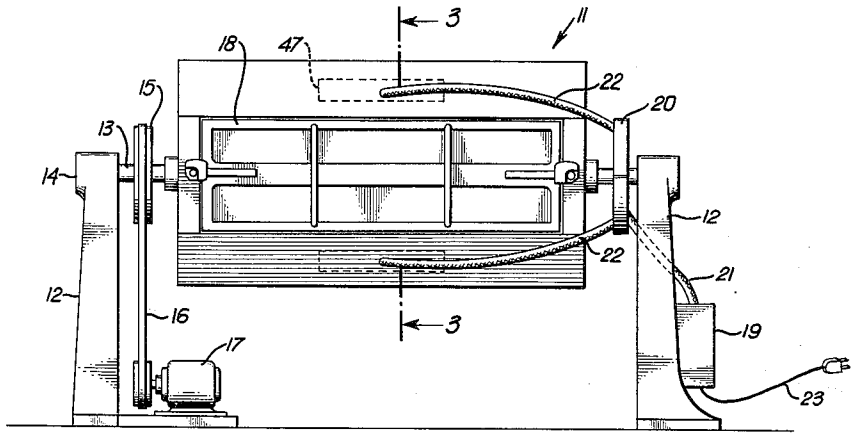


FIG. 1

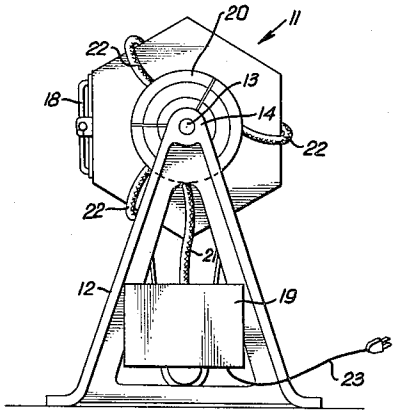


FIG. 2

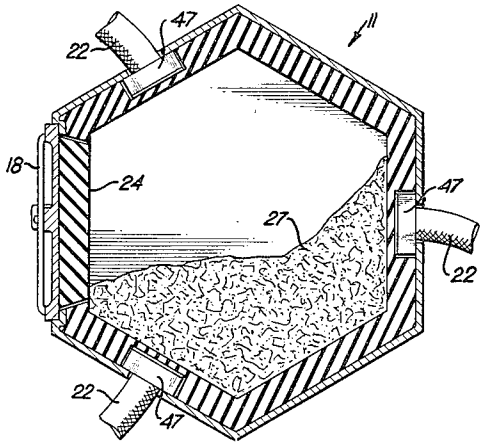


FIG. 3

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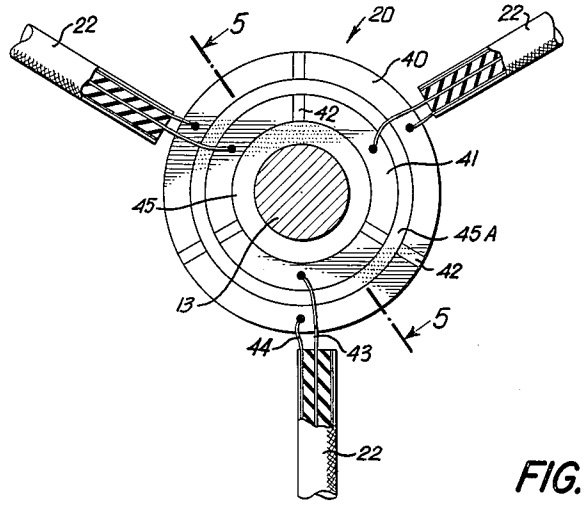


FIG. 4

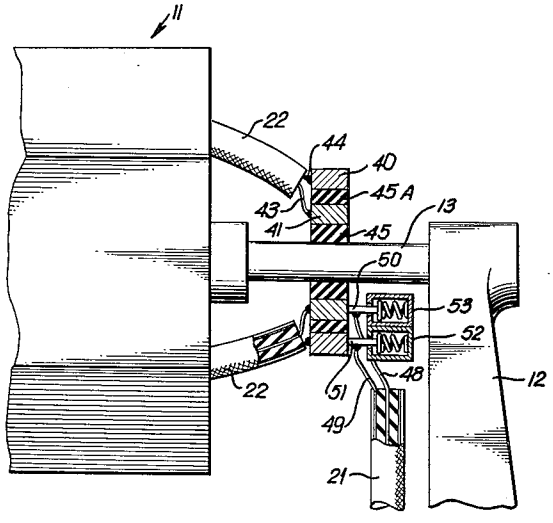


FIG. 5

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EQUIPMENT AND PROCESS FOR DEBURRING AND BURNISHING METAL PARTS

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This invention relates to new and novel equipment and process for deburring and burnishing of small parts.

In the manufacture of small components, particularly metal parts, it has been the practice to remove metal burrs, such as the flashings of die castings and the burrs produced by drilling operations either by hand operation with an abrasive tool, by electrolytic dissolution in a chemical solution or by the use of tumbling barrels containing abrasive particles. The tumbling barrels are usually considered the most efficient method of performing a deburring operation in mass-produced small dimensional articles because of the elimination of most manual handling of the parts.

It has also been found that after the parts are deburred, it is frequently necessary to burnish or polish the part either for reason of surface finish requirements; for reasons of utility; for the esthetic value of a highly lustrous part or for subsequent plating operations. Numerous methods have also been employed for burnishing or smoothing the small parts such as hand buffing, electro polishing, grit blasting, chemical polishing or tumbling in the presence of burnishing balls. This latter method has found widespread usage because of the low cost for manual labor, low power requirements, and small consumption of chemical agents. It has also been attractive from the standpoint of operational equipment as the deburring and burnishing operations can be conducted in the same equipment. Therefore, for the purpose of clarity, both burnishing and deburring shall hereinafter be referred to by the generic term "tumbling."

Although conventional tumbling procedures have been found both economical and efficient, there have been several inherent difficulties with the operation. It is generally recognized that in the deburring operation the time required to deburr a part was a function of the ductility, strength and hardness; a material of low ductility, low strength and relatively soft metal such as pot metal can be readily deburred in 10–30 minutes and burnished in 15 minutes to one hour, whereas a part of tempered chrome steel which is highly ductile, high strength and extremely hard may require from 8 to 24 hours to deburr and an equally long time to burnish or polish.

It is also generally recognized in the art that the longer a metallic part is tumbled the greater is the loss of metallic color or luster. This phenomenon is attributed to a number of factors including corrosion of the metal, hard water salt deposition, deposition from impurities in the tumbling media itself, and a number of other reasons.

It is also known that certain types of tumbling media, particularly porous abrasive used for deburring or grinding will tend to "load up"; that is, the pores become filled with small metallic particles which are removed from the metallic object being tumbled. In this instance, when an abrasive media has been used to grind or deburr brass, small particles of brass become deposited in the pores of the abrasive and the abrasive cannot be subsequently used on alloys such as aluminum, zinc or iron as the copper in the brass tends to be dissolved by chemicals present in the aqueous solution and redeposit on the above mentioned alloy, thereby causing unsightly appearing work and a poor base for plating or painting.

It is the object of my invention to overcome all of the aforementioned difficulties and provide a process and the equipment used therein which will greatly reduce the time necessary to produce comparable results now obtained with conventional equipment.

It is a further object to provide a process and the equipment used therewith, that is effective in cleaning media such as porous abrasive material, by removing the foreign matter from the media.

It is a further object of the invention to provide equipment that will produce a rapid and efficient method of cleaning the parts to be tumbled as well as cleaning all media of soil, hard water salt deposition and other soils.

I have found that when ultrasonic energy is applied to tumbling operation, which tumbling operation consists of treating parts, or parts and media, contained in a liquid such as water or an organic solvent, that a much more efficient operation results both from the standpoint of quality and time.

It has long been known that ultrasonic energy, that is, compressional waver of the sound type but of frequencies above audible sound and generally considered to be of the ranges of 10,000 to 400,000 cycles per second, are very effective in cleaning of metal parts in water or solvent systems; it has not been known, however, that the addition of ultrasonic energy to implement tumbling operations would produce any outstanding results. I have found, however, that the time required to produce deburring or burnishing of a specific metallic part can be reduced as much as 70% when ultrasonic energy is applied to the tumbling media.

The invention further resides in certain novel features of the combination of ultrasonic generating equipment and tumbling equipment, and further objects and advanatges thereof will be apparent to those skilled in the art of which the invention pertains from the following description of the presently preferred embodiment of the invention, and certain modifications thereof, taken in conjunction wtih the accompanying drawings, forming a part of this application, in which:

FIGURE 1 is a front view of a tumbling barrel to which has been attached an ultrasonic generator and associated equipment for producing ultrasonic energy within the barrel.

FIGURE 2 is a side view of FIGURE 1, showing the ultrasonic generation and attached wiring.

FIGURE 3 is a cross section taken along line 1—1 of FIGURE 1.

FIGURE 4 is a view of the rotary switch for transferring the electric currents from the stationary ultrasonic generator to the rotary barrel.

FIGURE 5 is a cross sectional view along line 3—3 of FIGURE 4.

A shown in FIGURES 1 and 2, a hexagonal tumbling barrel **11** is mounted on legs **12** by means of an axle **13** riding in a bearing housing **14**. The barrel is driven in a rotary manner by means of sheave **15** which is attached to axle **13** and driven by means of belt **16** which is in turn driven by motor **17**. On one of the hexagonal faces of the barrel, a removable water tight door **18** is mounted for ingress and egress to and from the barrel. Fixably mounted on the legs **12** is an ultrasonic generator **19** of the electronic type which is connected electrically to a rotating switch **20** by means of a coaxial cable **21**. After passing through the switch **20**, the ultrasonic electrical energy is fed to the various internally mounted vibration generators **47**, by means of coaxial cable **22**. The electrical energy for supplying the ultrasonic generator **19**, is supplied from an external source through power line **23**.

As shown in FIGURE 3, the tumbling barrel **11** is constructed of metal with an access door **18** mounted on one

side. The barrel is lined with a resilient material 24, the resilient material is usually rubber such as neoprene but may be of any other type rubber or plastic suitable for the purpose. Mounted in the rubber or covered with a suitable plastic or rubber material to prevent wear and shock, is an ultrasonic generating head 47 such as a barium titanate crystal or a magnetostrictive device which is supplied with ultrasonic frequency electrical energy through coaxial cables 22. Contained in the barrel is deburring aggregate 27 shown in its approximating angle of inclination resulting from the rotation of the barrel in the counter-clockwise direction. It will be noted that the aggregate will at all times cover at least one of the three ultrasonic generator heads 47.

As the barrel is rotated in the counter-clockwise direction, the aggregate 27 tends to pile up on the side of the barrel until the plane surface of the aggregate reaches an angle of incline which exceeds the critical angle and the aggregate at the top of the incline tends to roll down the slope such that as the barrel 11 is rotated, the angle of slope of the aggregate remains constant at its critical angle; to maintain this critical angle, the top surface of the aggregate must be continually in motion; which motion of aggregate over itself causes the actual deburring or finishing of the part contained in the aggregate 27.

As shown in FIGURES 4 and 5, the rotary switch 20 is fixably attached to the axle 13. The switch is constructed of two split ring concentric conductors, with outer split ring 40 and inner split ring 41; the inner split ring 41 is electrically insulated from the axle 13 by means of insulation 45 and the outer split ring 40 is electrically insulated from the inner split ring 41 by means of electrical insulation 45*a*. Each of the split ring conductors 40 and 41 consist of three individual segments, which segments are electrically insulated from each other by means of electrical insulation 42. The three pairs of segments of the outer and inner concentric split rings 40 and 41 respectively are connected to the ultrasonic generator heads in the barrel 11 by means of coaxial cables 22 which are constructed of an outer shield conductor 43 and an inner conductor 44.

The ultrasonic electrical energy from the ultrasonic electrical generator 19 is fed to the rotary switch 20 by means of coaxial cable 21 which is constructed with an internal conductor 48 and an external shield conductor 49. The internal conductor 48 is attached to a brush 50 and the external shield conductor 49 is attached to brush 51. The brushes 50 and 51 are pressed against the surfaces of the rotary switch by means of positive pressure exerted by means of helical springs 53 and 52 respectively. It is the principle of operation that electrical ultrasonic energy is generated by the generator 19 which energy is fed up through coaxial cable 21 and to the brushes 52 and and 53; which ride on the surface of the concentric split ring conductor 40 and 41 and thereby pass electrical energy from the brushes 52 and 53 to one pair of segments of the split ring conductors, which pair of segments is electrically connected to one of the ultrasonic generating heads 47 located in the barrel 11 by means of coaxial cable 22 which is fixably connected to the pair of conductors. The brushes 50 and 51 are so positioned with relationship to the barrel 11 that only the ultrasonic generator head 47 which is nearest the bottom of the barrel 11 during the revolution thereof is activated. The ultrasonic generating head 47, in this bottom position is therefore always adjacent to the aggregate 27 and as the ultrasonic generator head 47 is excited by an ultrasonic electrical current from ultrasonic electrical generator 19, compressional ultrasonic waves are created within the body of the aggregate 27 and the fluid surrounding it.

Example "A"

A plastic coated barium titanate crystal was mounted on the inside of an hexagonal tumbling barrel and imbedded in the rubber lining thereof so that the surface of the plastic was flush with the inside surface of the rubber lining. The crystal was activated with a 40,000 cycle per second electrical impulse operated with maximum pulse power of approximately 2 kilowatts. The barrel was charged to about one half full with fused aluminum oxide chips; one hundred zinc die cast desk drawer knobs were placed in the barrel; about two ounces per gallon of water treating and inhibiting compound composed of sodium tripolyphosphate 20%, borax 70%, sodium chromate 5%, non-ionic wetting agent 5% was added and water was added to fill the barrel to about one inch below the top of the chips; the barrel was then rotated at 25 revolutions per minute and inspection of the parts was made every minute to determine when the deburring was completed. It was found that nine minutes was required to completely remove the flashing from the parts employing this procedure. When identical parts were treated in the same manner without the use of ultrasonic energy, fifteen minutes were required to produce a comparable result in removal of the flashing from the part. Therefore the time reduction in this operation was 40%. It was also observed that the part produced by conventional procedures without ultrasonic energy was much darker in color, in other words, had much less metallic lustre, than the part produced in nine minutes employing ultrasonic energy.

Example "B"

The deburred parts of Example "A" were then burnished in the same barrel. The barrel was charged to approximately one half full with steel burnishing balls, burnishing compound composed of coconut oil soap 98%, sodium salt of ethylene diamine tetrasetic acid 2%, was added in a quantity of one ounce per gallon of water; water was then added to the barrel in an amount to just cover the burnishing balls; the parts were then added to the barrel; the barrel was then rotated at a speed of 35 revolutions per minute and the parts inspected for lustre every minute. With conventional procedures, the parts were burnished to a high lustre in 35 minutes. The test was then repeated using the same ultrasonic energy sound as discussed in Example "A" above. It was found that at the end of 12 minutes the parts had achieved a lustre comparable to that achieved in 35 minutes with conventional procedures and in addition the metallic color of the parts produced using ultrasonic energy was much superior.

Example "C"

The same barrel as Example "A" was then used for deburring of a brass washer that had been stamped from sheet stock. The charge was identical to that used in Example "A" but new aluminum oxide chips were employed. It was found that the brass washers were deburred in 45 minutes using conventional methods but only 27 minutes was required to produce comparable results when ultrasonic energy was used. It was also observed that when conventional methods were employed, the aluminum oxide chips loaded up with brass chips to a much greater extent than when ultrasonic energy was employed.

Example "D"

When the chips used by the conventional method of Example "C" above were placed in the barrel, the barrel filled with water sufficient to just cover the chips and a burnishing compound composed of coconut oil soap 98% and sodium salt of ethylene diamine tetracetic acid 2% was added to the extent of one ounce per gallon of solution and the barrel rotated at 25 revolutions per minute for a period of 10 minutes employing the ultrasonic energy, the chips were then washed with water and were found to be relatively free of brass chips and the suds produced by the soap and water contained visable chips of brass which had been removed from the aluminum oxide chips and were suspended in the foam.

Example "E"

A batch of polished steel burnishing balls were specifically contaminated with a tarry mixture of coal-tar nitrogen bases. One-half of the balls were then introduced into a tumbling barrel and one-half of the zinc die cast desk drawer knobs of Example "B" were introduced together with water and 2 oz./gal. of burnishing soap. It was found that at the end of 35 minutes, the parts were very smooth but had acquired a very dark color which was not acceptable.

The remaining one-half of the tar treated balls was then charged into the machine together with the remaining one-half of the zinc die cast desk drawer knobs and water was added to just cover the balls; the deburring compound was then added in a quantity of 2 oz./gal. of water and the ultrasonic energy was applied. At the end of 15 minutes rotation of the tumbling barrel at 30 revolutions per minute, it was found the balls were clean and free of tar as evidenced by the water wetability of the balls and the desk drawer knobs were highly burnished with good metallic lustre without darkening.

It is therefore obvious that the use of ultrasonic energy in combination with conventional tumbling procedures produce an unexpected utilitarian result.

Although one modification of the equipment useful in employing the process is graphically described, it will be obvious to those skilled in the art that other and varied combinations will produce similar results and that such other and varied combinations of ultrasonic generators and tumbling equipment are within the spirit of the invention.

What I claim is:

1. Deburring and burnishing apparatus comprising a tumbling barrel mounted for rotation about an essentially horizontal axis, means connected to said barrel for transmitting rotation thereto, a plurality of separate means for converting ultrasonic electrical energy into ultrasonic mechanical energy mounted approximately equidistant from each other in the horizontal surfaces of said barrel and means for cyclically supplying ultrasonic electrical energy to the single one of said separate means which is nearest the bottom of said barrel during revolution thereof.

2. The apparatus of claim 1, wherein the separate means for converting ultrasonic electrical energy into ultrasonic mechanical energy is a magnetostrictive ultrasonic mechanical generator.

3. The apparatus of claim 1, wherein the said separate means for converting ultrasonic electrical energy into ultrasonic mechanical energy is a piezo-electric crystal.

4. In a tumbling barrel consisting of a barrel for retaining aggregate, solution and parts rotated about an axis essentially in a horizontal plane by means of an external mechanical power source, the improvement which comprises an ultrasonic frequency electrical generator, a plurality of ultrasonic mechanical generators mounted approximately equidistantly from each other in the horizontal surfaces of said barrel and means for activating said generators by said ultrasonic electrical generator only when said mechanical generators are in contact with the aggregate and solution contained in the barrel during the rotation thereof.

5. The improved apparatus of claim 4, wherein said mechanical generators are magnetostrictive ultrasonic generators.

6. The improved apparatus of claim 4 wherein the mechanical generators are piezo-electric crystals.

7. The improved apparatus of claim 4 wherein the means for transferring the output current of the electrical generator to said independent mechanical generators comprises a pair of concentric split ring conductors, each of said rings having a plurality of segments of substantially equal length and corresponding in number to the number of said mechanical generators, means for electrically connecting each of said segments to one of said generators disposed on the same side of said barrel as said segment and a pair of brushes electrically connected to said electrical generators and being disposed to contact said conductor rings at the lowermost position thereof.

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